

EFFECTS OF PENDIMETHALIN ON POD ATTRIBUTES OF FIVE ELITE ACCESSIONS OF COWPEA

DJELOVANJE PENDIMETHALINA NA DIJELOVE MAHUNE PET ELITNIH VRSTA STOČNOG GRAŠKA

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ABSTRACT

A field study on the effects of pre- and post-emergence application of herbicide (pendimethalin) on the reproductive yield of five accessions of cowpea (TVu-9092, TVu-16265, TVu-16320, TVu-16323 and TVu-16421) was conducted between June and August, 2018. Pendimethalin was applied both as pre- and early post-emergence herbicide (PE and EPOE) and followed by hand weeding at 4 and 8 weeks after sowing (WAS). Number of pods per plant was highest in TVu-9092 treated with 0.125 kg/ha PE pendimethalin (19.33) and 0.250 kg/ha pendimethalin EPOE application (19.00). Highest pod diameter in PE treatment was produced in TVu-16320 with 0.25 kg/ha pendimethalin (7.55 mm) and TVu-16323 with 0.125 kg/ha pendimethalin produced the highest pod diameter (7.74 mm) in the EPOE treatment. Highest pod length in the PE treatment was produced in TVu-9092 with 0.125 kg/ha, while TVu-9092 without pendimethalin produced the highest pod length (30.00 cm) in the EPOE treatment. In the PE treatment, TVu-16265 and TVu-9092 treated with 0.125 kg/ha had the highest (2.99 g) and lowest empty pod weights (1.70 g) respectively. In the EPOE treatment, the highest empty pod weight (3.01 g) was produced in TVu-16265 with 0.125 kg/ha pendimethalin while the control of TVu-16320 recorded the lowest empty pod weight (2.03 g). The highest of 100 seeds weight (14.91 g) was produced in TVu-16421 with 0.125 kg/ha pendimethalin PE treatment and lowest (9.26 g) was obtained in the untreated control of TVu-16323. In the post-emergence treatment, the lowest 100 seeds weight (8.88 g) was obtained in TVu-16320 with 0.125 kg/ha. Highest weight per pod in the PE and EPOE application was obtained in untreated control with TVu-9092 (10.47 g), while the lowest weight per pod (3.22 g) was in TVu-16265 with 0.125 kg/ha EPOE application. The study

concluded that pendimethalin application as pre- and early post-emergence herbicide at low and high concentrations produced varying effects on pod attributes among the accessions of cowpea.

Key words: herbicide, leaves, pod, pod length, pod weight, seed per pod

SAŽETAK

Terensko istraživanje primjene herbicida (pendimetalina) prije i poslije klijanja na reproduktivni prinos pet vrsta stočnog graška (TVu-9092, TVu-16265, TVu-16320, TVu-16323 i TVu-16421, provedeno je između lipnja i kolovoza 2018. godine. Pendimetalin je primijenjen kao herbicid prije i poslije klijanja (PE i EPOE) nakon čega je slijedilo ručno pljevljenje 4 i 8 tjedana nakon sijanja (WAS). Broj mahuna po biljci bio je najveći kod TVu-9092 tretiranog sa 0,125 kg/ha PE pendimetalina (19,33) i 0,250 kg/ha pendimetalina EPOE (19,00). Najviši promjer mahune u PE tretmanu nastao je u TVu-16320 s 0,25 kg/ha pendimetalina (7,55 mm), a TVu-16323 s 0,125 kg/ha pendimetalina proizveo je najveći promjer mahune (7,74 mm) u tretmanu EPOE. Najveća duljina mahuna u PE obradi proizvedena je u TVu-9092 s 0,125 kg/ha, dok je TVu-9092 bez pendimetalina proizvela najveću duljinu mahune (30,00 cm) u EPOE tretmanu. U PE postupku TVu-16265 i TVu-9092 sa 0,125 kg/ha imao najviše (2,99 g) i najniže težine prazne mahune (1,70 g). U EPOE postupku najveću težinu prazne mahune (3,01 g) imao je TVu-16265 sa 0,125 kg/ha pendimetalina dok je kontrola TVu-16320 zabilježila najnižu težinu prazne mahune (2,03 g). Najveća težina 100 sjemenki (14,91 g) zabilježena je u TVu-16421 sa 0,125 kg/ha pendimetalina dok je kontrola TVu-1632 zabilježila najnižu težinu prazne mahune (2,03 g). Najviša težina sto sjemenki (14,91 g) proizvedena je u TVu-16421 sa 0,125 kg/ha pendimetalina i najniža (9,26 g) u netretiranoj kontroli TVu-16323. U postupku nakon klijanja najniža težina 100 sjemenki (8,88 g) zabilježena je u TVu-16320 najniža težina prazne mahune (2,03g). Najviša težina 100 sjemenki u postupku PE i EPOE dobivena je u netretiranoj kontroli sa TVu-9092 (10,47g) dok je najniža težina po mahuni (3,22 g) bila kod TVu-16265 sa 0,125 kg/ha EPOE. U radu je zaključeno da je primjena pendimetalina prije i odmah poslije klijanja u niskim i visokim koncentracijama imala različito djelovanje na mahunu raznih vrsta stočnog graška.

Ključne riječi: herbicid, listovi, mahuna, duljina mahune, težina mahune, sjeme po mahuni

INTRODUCTION

Cowpea, *Vigna unguiculata* (L.) Walp, is one of the most important grain legumes in many countries of the tropics, particularly Asia and Africa (Asiwe *et al.*, 2009; Osipitan, 2017). Cowpea has been described as the most important crops to the livelihoods of millions of relatively poor people in less developed countries of the tropics (FAO, 2012) and it was regarded as the most economically important indigenous African leguminous crop (Ugbe *et al.*, 2016). Globally, an estimated 3.7 million metric tonnes of cowpea is produced annually on about 8.7 million hectares (Langyintuo *et al.*, 2003). Africa accounted for about 87% of annual cowpea production, America for 10% while Europe and Asia for the rest (Ugbe *et al.*, 2016). Cowpea is a major source of plant protein in Nigeria and most other African countries as the grains contain about 25% protein, and several vitamins and minerals (Mbata *et al.*, 2000). In many parts of the world, cowpea served as fodder for many animals.

Despite many importance of cowpea, its yield is generally low as a result of some factors such as diseases and pests, drought, insect pest and weeds (Gungula and Garjila, 2005). Weeds constitute the most important constraints that influence cowpea production in the tropics (Keramati *et al.*, 2008) as it competes with crops, reduce their growth rate, quantity and quality of grain yield as well as increase the cost of production (Akobundu, 1987). In fact, yield reductions of 13-82% have been reported in cowpea due to weed competition (Li *et al.*, 2004; Tripathi and Singh, 2001). Also, Muhammad *et al.* (2003) reported that, weed competition with cowpea reduced yield by 82% and a significant increase pods yield was recorded by controlling weeds up to 45 days of sowing. Cowpea yield can be as low as 110 kg/ha on weedy farmers' fields in northern guinea savanna of Nigeria which is the heart of its growing region in West and Central Africa (Oyekanmi and Sangodoyin, 2007). A timely weed removal at the critical period, which falls within the first 40 days of cowpea growth, would help to prevent yield loss (Osipitan, 2017). Therefore, in order to enhance crop yield, weed control during this period is very important.

Physical and mechanical approaches of weed control are very expensive (Khan *et al.*, 2004), due to high cost of labour, logistic problem or limited availability of labour. Thus, on medium to large scale cropping, chemical weed control seems to be easiest form of controlling weed as it is more convenient, faster and reduce labour cost. The advantage of herbicides in increasing yield of crops and reducing labour cost is said to be of great importance to farmers in Nigeria (Melifonwu, 1992).

According to Patel *et al.* (2003), significantly higher grain yield and net return of cowpea were obtained with pre-emergence application of (Pendimethalin at 0.75 kg ha⁻¹ plus weeding at 5 weeks after planting) compared to other treatments. Also, Singh *et al.* (2004) reported that application of herbicide and hand weeding (Pendimethalin at 1.0 kg ha⁻¹ plus hand weeding at 30 days after planting) produced significantly higher cowpea grain yield and reduced weed density and biomass. The use of herbicides may therefore provide a timely and adequate alternative to hand weeding as this not only removes the drudgery associated with it but also lowers the cost of weeding and provides protection for crop against early weed competition when pre-emergence herbicides are used (Akobundu, 1987). Nonetheless, cowpea is believed to be more sensitive to herbicides than other leguminous species. Therefore, it is important to investigate the effects of pendimethalin herbicide on the yield components of cowpea. Thus, this study assessed the effect of pendimethalin on the reproductive yield and seed related traits of five elite varieties of cowpea from the germplasm of International Institute for Tropical Agriculture, Nigeria.

MATERIALS AND METHODS

Description of experimental site

The experiment was conducted at the Botanical garden of the Department of Plant Biology, University of Ilorin, Kwara State, Nigeria, during the rainy season between June and August 2018. University of Ilorin is located in guinea savanna agro-ecological zone of Nigeria on latitude 8° 24' N and 8° 36' N and longitude 4° 10' E and 4° 36' E. The climate is tropical with average annual temperature of 26.5 °C and rainfall of 1217 mm (World Site Atlas, 2018).

Experimental layout, land preparation and germplasm collection

The land used for the experiment was cleared and ridges were prepared manually using hand hoe. The treatments were allotted in a randomized block design (RBD). Five elite accessions of cowpea (TVu-9092, TVu-16265, TVu-16320, TVu-16323 and TVu-16421) from germplasm of the International Institute for Tropical Agriculture (IITA), Ibadan, Oyo State, Nigeria were used for the study.

TVu-9092 is a member of TVu-9 accessions (cultivar C3) collected in 1971 from the Ministry of Agriculture and Natural Resources (MANR), Nigeria by IITA. The growth habit of TVu-9092 accession is semi-prostrate with the main

stem at 20 cm or more above the ground and the branches spreading 1 to 4 m. The accession is resistant to *Cercospora canescens* leaf spot disease, bacterial blight and target spot diseases (IITA, 2021a). TVu-16265, TVu-16320, TVu-16323 and TVu-16421 are among TVu-16 series (cultivar C-1968) of IITA. The accessions are among the over 300 traditional cultivars of cowpea collected by IITA from MANR in 1971. The growth habit is erect (about 37.5 cm tall) with the branches forming acute angle with the main stem. The accessions are also resistant to leaf spot diseases of *C. canescens* and *C. cruenta*, bacterial blight, target spot and rust (IITA, 2021b).

Treatment application and assessment of its effects

Pendimethalin (herbicide) was applied as pre-emergence (PE) immediately after sowing at planting and as post-emergence (EPOE) at 10 days after emergence, followed by two hand weeding at 4 and 8 WAS. Two concentrations (0.125 and 0.250 kg/ha) of the herbicide were used. Sowing was done by direct manual sowing, at a depth of 5 cm, and one seed per position (hole). The pre-emergence (PE) herbicide was applied immediately after the seeds were sown while the early post emergence (EPOE) herbicide treatment was applied 10 days after emergence of the seedling. Using 25-Litre knap-sack sprayer. Watering was carried out at an interval of 2-3 days as required when there was no rain. The reproductive parameters were taken at maturity. Each treatment was replicated three times without any treatment allotted to the control plots which were left weedy throughout the period of the experiment.

Data collection and Analysis

Sampling was done at 2 weeks' interval after germination of the crop. Three plants were randomly selected from each treatment per plot for the study. At harvest, data were collected on pod diameter, pod length, number of seed per pod, weight of pod, weight of 100 seeds and weight of empty pods (a feed source for livestock). The data collected from the study were analyzed by analysis of variance (ANOVA) using statistical package for social sciences (SPSS: version 16.0). The means were separated by Duncan Multiple Range Test (DMRT) at ($P < 0.05$).

RESULTS AND DISCUSSION

In PE pendimethalin application, As seen in Table (1) the number of pods per plant in the pre-emergence (PE) treatment was highest in TVu-9092 treated with 0.125 kg/ha pendimethalin (19.33) and lowest in TVu-16323

with 0.250 kg/ha pendimethalin (13.00). In the early post-emergence (EPOE) treatment, TVu-9092 treated with 0.250 kg/ha pendimethalin and TVu-16320 control plants had the highest number of pods (19.00).

In the PE treatment, TVu-16320 treated with 0.25 kg/ha of pendimethalin recorded the highest pod diameter (7.55 mm) and was significantly different from the other treatments ($P < 0.05$). The TVu-9092 control plant and those treated with 0.125 kg/ha of pendimethalin; TVu-16265 control plant and those treated with 0.125 and 0.25 kg/ha of pendimethalin; TVu-16320 control plant; TVu-16323 control plant and TVu-16421 treated with 0.125 kg/ha of pendimethalin recorded pod diameter values that were not significantly different ($P < 0.05$). The least pod diameter was recorded by TVu-16421 treated with 0.25 kg/ha of pendimethalin (5.97 mm). Meanwhile in EPOE pendimethalin application, the highest and lowest pod diameters were recorded in TVu-16323 treated with 0.125 kg/ha of pendimethalin (7.74 mm) and TVu-9092 treated with 0.125 and 0.25 kg/ha of pendimethalin respectively.

In PE pendimethalin (6.21 mm) application, there was no significant difference between pod lengths of TVu-9092 control plant and those treated with 0.125 and 0.25 kg/ha ($P < 0.05$) (Tables 1). However, those treated with 0.125 kg/ha recorded the highest pod length. The trend of the effect was similar for the EPOE pendimethalin application. The pod length of TVu-9092 (control plant) and those of the accession treated with 0.125 and 0.25 kg/ha of pendimethalin did not show significant difference ($P < 0.05$). Nevertheless, the control plant had the highest pod length. Reduction in pod length for pre-emergent (PE) application of pendimethalin as compared to post-emergent (EPOE) pendimethalin application corroborated the findings of Ademiluyi and Joseph (2016) who reported a reduction in pod length of cowpea when pendimethalin was applied as post-emergent herbicide. Moreover, Makinwa and Akinyemiju (1990) had earlier demonstrated that applying the herbicide at this stage could effectively suppress the weeds and may be better tolerated by the cowpea which may result into better performance in terms of yield components.

For the PE pendimethalin application, although number of seed per pod was highest (19.33) in TVu-9092 treated with 0.125 kg/ha, it was not significantly different ($P < 0.05$) from the seed yield of the control and TVu-16320 treated with 0.125 kg/ha (Table 1). The result further showed that EPOE pendimethalin application at 0.25 kg/ha favoured number of seed/pod with the highest recorded for TVu-16320. However, it was not significantly different from TVu-9092 control plant and those treated with 0.125 kg/ha, and TVu-16320 treated with 0.125 and 0.25 kg/ha of pendimethalin which had 17.33, 18.33,

18.00 and 17.33 seed/pod respectively. The present result was in congruence to the report of Ademiluyi and Joseph (2016) who elucidated that a higher number of seeds per pod were produced in cowpea when pendimethalin was sprayed as pre-emergent herbicide rather than post-emergent. These results demonstrated that better yield performances could be obtained in cowpea plots where pendimethalin herbicide was applied at pre-emergent level. This observation was further affirmed and attributed to lower phytotoxicity of pendimethalin to cowpea when applied as pre-emergent herbicide rather than post-emergent herbicide, resulting in higher number of seeds per pod (Costa *et al.*, 2017).

Table 1 Effect of pendimethalin application on pod attributes of five elite cowpea accessions.

PE – pre-emergence pendimethalin application, EPOE – early post-emergence pendimethalin application, values are means and those with similar letter(s) in a column are not significantly different at (P<0.05) level.

Tablica 1. Učinak primjene pendimetalina na dijelove mahuna pet elitnih vrsta stočnog graška. PE - primjena pendimetalina prije nicanja, EPOE - rana primjena pendimetalina nakon nicanja, (P <0,05).

Variety/Concentration	Number of pod/plant		Pod diameter (mm)		Pod length (cm)	
	PE	EPOE	PE	EPOE	PE	EPOE
TVu-9092						
Control	17.33 ^{ab}	17.33 ^{ab}	6.49 ^{abc}	6.49 ^{bc}	30.00 ^a	30.00 ^a
0.125kg/ha	19.33 ^a	18.33 ^a	6.92 ^{abc}	6.21 ^c	31.00 ^a	27.67 ^a
0.250 kg/ka	17.00 ^{abc}	19.00 ^a	6.22 ^{bc}	6.21 ^c	28.67 ^a	28.67 ^a
TVu-16265						
Control	14.67 ^{cd}	14.67 ^{cd}	6.63 ^{abc}	6.63 ^{bc}	17.00 ^d	17.00 ^d
0.125kg/ha	15.00 ^{bcd}	15.00 ^{cd}	6.70 ^{abc}	7.01 ^{abc}	18.67 ^d	17.67 ^d
0.250 kg/ka	14.33 ^d	16.00 ^{bc}	6.49 ^{abc}	7.33 ^{ab}	17.50 ^d	18.17 ^d
TVu-16320						
Control	19.00 ^a	19.00 ^a	6.77 ^{abc}	6.77 ^{abc}	25.00 ^b	25.00 ^b
0.125kg/ha	18.33 ^a	18.00 ^a	7.21 ^{ab}	7.11 ^{abc}	22.00 ^c	23.67 ^b
0.250 kg/ka	18.00 ^a	17.33 ^{ab}	7.55 ^a	6.76 ^{abc}	23.67 ^{bc}	21.17 ^c
TVu-16323						
Control	15.33 ^{bcd}	15.33 ^{cd}	6.48 ^{3abc}	6.48 ^{bc}	16.33 ^d	16.33 ^d
0.125kg/ha	15.33 ^{bcd}	15.00 ^{cd}	7.14 ^{ab}	7.74 ^a	16.67 ^d	17.00 ^d
0.250 kg/ka	13.00 ^d	15.00 ^{cd}	7.26 ^{ab}	7.00 ^{abc}	17.33 ^d	17.33 ^d
TVu-16421						
Control	14.67 ^{cd}	14.67 ^{cd}	7.22 ^{ab}	7.22 ^{abc}	18.00 ^d	18.00 ^d
0.125kg/ha	13.67 ^d	13.67 ^d	6.81 ^{abc}	6.97 ^{abc}	17.00 ^d	17.50 ^d
0.250 kg/ka	15.00 ^{bcd}	15.00 ^{cd}	5.97 ^c	6.52 ^{bc}	18.00 ^d	18.67 ^d

In term of pod weight, highest and lowest pod weights were recorded by TVu-16265 treated with 0.125 kg/ha and TVu-16320 treated with 0.25 kg/ha of PE pendimethalin (2.99 g and 1.91 g) respectively (Table 2). This trend was similar for the EPOE pendimethalin application. However, TVu-16320 of the untreated plot produced the least pod weight (2.03 g). In tandem with this, Ademiluyi and Joseph (2016) reported a higher weight of pod when pendimethalin was sprayed as pre-emergent herbicide rather than post-emergent.

The highest weights of 100 seeds were produced in TVu-16421 when pendimethalin was applied at PE and EPOE (14.07 and 14.36 g). The lowest weight of 100 seeds was recorded in variety TVu-16323 control (9.26 g) when pendimethalin was applied as PE herbicide. However, with application of pendimethalin at EPOE, the lowest weight of 100 seeds occurred in TVu-16320 with 0.125 kg/ha pendimethalin concentration (8.88 g). This observation suggests that the application of pendimethalin herbicide did not result in lethal effect on the cowpea which was in accordance with earlier report by Oluwafemi and Abiodun (2016) who studied the comparative evaluation of hoe-weeding and pendimethalin on weed management in cowpea.

Furthermore, application of pendimethalin as PE and EPOE herbicide resulted in highest empty pod weight in TVu-9092 control plants (10.47 g) (Table 2). Empty pods of legumes such as peas and cowpeas are fed to animals (Wadhwa and Bakshi, 2013; Wadhwa *et al.*, 2017), mulching and biomass fuel. The lowest weights of empty pod when pendimethalin was applied as pre- and post-emergence were recorded by TVu-16320 treated with 0.25 kg/ha of pendimethalin and TVu-16265 treated with 0.125 kg/ha of pendimethalin (4.49 and 3.32 g) respectively. TVu-9092 showed varietal advantage over other accessions by recording low weights of empty pods when pendimethalin was applied as PE and EPOE herbicides. This finding is in consonance with earlier report by Choudhary *et al.* (2013) who studied the response of cowpea to fertility levels and mulching and many other workers (Chinnusamy *et al.*, 2010; Hussaini and Lado, 2010) who had earlier investigated the effects of chemical herbicides and their concentrations on performance and yield of cowpea.

Table 2 Effect of pendimethalin application on pod and weights (g) of five elite cowpea accessions. PE – pre-emergence pendimethalin application, EPOE – early post-emergence pendimethalin application, values are means and those with similar letter(s) in a column are not significantly different at (P<0.05) level.

Tablica 2. Učinak primjene pendimetalina na težinu mahune (g) pet elitnih vrsta stočnog graška. PE - primjena pendimetalina prije nicanja, EPOE - rana primjena pendimetalina nakon nicanja, (P<0.05)

Variety/ Concentration	Weight of pod (g)		Weight of 100 seeds (g)		Weight of empty pods (g)	
	PE	EPOE	E	EPOE	PE	EPOE
TVu-9092						
Control	10.47 ^a	10.47 ^a	9.57 ^b	9.57 ^{cd}	2.27 ^{bcd}	2.27 ^{ab}
0.125kg/ha	7.84 ^{ab}	7.88 ^{abc}	10.34 ^b	9.69 ^{cd}	1.70 ^{ab}	2.63 ^{ab}
0.250 kg/ka	8.50 ^{ab}	7.75 ^{abc}	9.87 ^b	11.13 ^{bc}	2.68 ^{ab}	2.37 ^{ab}
TVu-16265						
Control	9.20 ^{ab}	9.20 ^{ab}	12.89 ^a	12.89 ^{ab}	2.51 ^{abc}	2.51 ^{ab}
0.125kg/ha	8.40 ^{ab}	3.32 ^c	13.66 ^a	14.03 ^a	2.99 ^a	3.01 ^a
0.250 kg/ka	4.69 ^b	5.60 ^{abc}	13.93 ^a	14.62 ^a	2.73 ^{ab}	2.37 ^{ab}
TVu-16320						
Control	5.48 ^b	5.48 ^{bc}	13.11 ^a	13.11 ^a	2.03 ^{cd}	2.03 ^b
0.125kg/ha	5.41 ^b	4.58 ^{bc}	10.14 ^b	8.88 ^d	2.03 ^{cd}	2.53 ^{ab}
0.250 kg/ka	4.69 ^b	3.61 ^c	9.27 ^b	8.98 ^d	1.91 ^d	2.17 ^b
TVu-16323						
Control	5.21 ^b	5.21 ^{bc}	9.26 ^b	9.62 ^{cd}	2.53 ^{ab}	2.53 ^{ab}
0.125kg/ha	6.07 ^{ab}	4.81 ^{bc}	14.72 ^a	14.09 ^a	2.37 ^{bcd}	2.60 ^{ab}
0.250 kg/ka	4.49 ^b	6.48 ^{abc}	13.92 ^a	13.40 ^a	2.63 ^{ab}	2.63 ^{ab}
TVu-16421						
Control	6.58 ^{ab}	6.58 ^{abc}	14.29 ^a	14.29 ^a	2.39 ^{bcd}	2.39 ^{ab}
0.125kg/ha	5.83 ^b	4.76 ^{bc}	14.91 ^a	13.86 ^a	2.69 ^{ab}	2.44 ^{ab}
0.250 kg/ka	6.74 ^{ab}	9.25 ^{ab}	14.07 ^a	14.36 ^a	2.43 ^{bcd}	2.51 ^{ab}

CONCLUSION

Pre- and early post-emergence application of pendimethalin at low (0.125 kg/ha) and high (0.250 kg/ha) concentrations affected pod attributes differently among the five accessions of cowpea used in this study. High concentration of the herbicide applied at post-emergence increased the number of pods in TVu-9092, TVu-16265 and TVu-16421. PE and EPOE applications at low and high concentrations improved seeds weight in TVu-9092, TVu-16265

and TVu-16323 while reducing the weight per pod. Pendimethalin, regardless of concentration and period of application, increased weight of empty pods in TVU-16265 and TVu-16421. The study concluded that pendimethalin application as pre- and early post-emergence herbicide at low and high concentrations produced varying effects on the pod attributes among the accessions of cowpea.

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